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Preliminary Report on The District Municipality of Muskoka Sewage Lagoon Network for Septic Tank and Holding Tank Wastes

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Ministry of the Environment
Ontario

P. G. Cockburn
Director
Central Region

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SUMMARY

The District Municipality of Muskoka, because of insufficient suitable land disposal areas, installed five sewage lagoons to accept the wastes collected from septic tank and/or holding tanks. These lagoons were also installed to reduce the number of instances of indiscriminate dumping of sewage. The municipality felt that a municipally controlled facility could achieve this purpose and it appears to have been fairly successful.

The lagoons were originally designed as total retention lagoons; however, such a network is not practical. Therefore, investigations are presently being carried out to determine the most suitable method for discharge.

One attempt to chemically treat a lagoon with alum was not fully effective since the quality of the effluent for direct discharge did not meet the Ministry's standards for B.O.D. and suspended solids. On the other hand, the criteria for total phosphorus was obtained.

Disposal via the ridge and furrow method is feasible when suitable land is available.

Access to the lagoons is controlled by fencing with a lockable gate. Only authorized sewage haulers have keys. This method appears suitable with only the rare occurance of sewage being deposited at the gate.

A problem that has been encountered is the deposit of plastic bags containing sewage into the lagoons. These bags float on the surface and interfere with the pumping and chemical treatment. The bags are thought to originate from motorized vehicles, travel trailers, head equipped boats, ice shelters, and during the winter, at some cottages.

One distinct advantage of these lagoons is the relatively low operating costs. Presently, it costs the District between \$3.50 to \$5.00/1,000 gallons of sewage. No cost information is presently available on the amount of road maintenance required. The capital cost is approximately \$130/1,000 gallons.

Preliminary results indicate that a network of sewage lagoons is a viable solution to the problem of septic tank and/or holding tank waste disposal. Further research into chemical treatment and the plastic bag problem is required. Also a continuing sampling program should be carried out to define more clearly the quality of the wastes in these facilities.

CHAPTER ONE

Introduction

1.1 General

Historically, septic tank and holding tank wastes have been spread on farmland and disced or ploughed into the soil. Unfortunately, the soil conditions in all parts of the Province of Ontario are not suitable for this method of disposal. As a result, complaints of indiscriminate dumping of septic tank and holding tank wastes into streams and other unsuitable areas, causing environmental degradation were received. Thus, some means of reducing this type of degradation was required, especially within the District Municipality of Muskoka which is primarily a water oriented recreational area having a limited soil depth.

1.2 Program Inception

The District Municipality of Muskoka decided that it wanted septic and holding tank wastes dumped under controlled conditions. A suitable solution appeared to be a system of sewage lagoons throughout the District. Applications were made to the Ontario Water Resources Commission, now the Ministry of the Environment, for approval of such a network.

This type of network was initiated on an experimental basis to see if it would supply a solution to disposal of septic and/or holding tank wastes.

1.3 Initiation of Report

This network of sewage lagoons has been in operation for several seasons and enquiries from other parts of the Province has resulted in the request for a preliminary evaluation of the system. This report is to provide such a preliminary evaluation with recommendations for future consideration.

CHAPTER TWO

System Design, Capital and Operating Costs

2.1 Location

The location of these facilities relative to the area that is to be served is imperative. The District Municipality of Muskoka feels that sewage haulers will travel 8 to 10 miles to discharge their load. This figure is verified by research done by James F. MacLaren, Ltd., in a March, 1973 report, which indicated that the average haulage distance is 6 to 10 miles.

The District of Muskoka has presently established five (5) sites within the municipality:

1. Twelve Mile Bay Lagoon, Township of Georgian Bay, Lot 26, Conc. 3, Freeman Ward, July, 1972.

2. South Bay Lagoon, Township of Georgian Bay, Lot 29, Conc. 9 & 10, Baxter Ward, September, 1973.

3. Stephenson Lagoon, Town of Huntsville, Lot 32, Conc. 14, September, 1973.

4. Dwight Lagoon, Township of Lake of Bays, Lot 4, Conc. 8, Township of Franklin, August, 1972.

5. Baysville Lagoon, Township of Lake of Bays, Lot 21, Conc. 4, McLean Ward, October, 1973.

The sites were established at the request of the local township. At the present time, the town of Gravenhurst and the Township of Muskoka Lakes have also requested similar facilities.

2.2 Design Criteria

The municipality had decided that the lagoon system was the most practical system for their area since suitable land and sewage treatment plants of adequate capacity were not available near areas requiring service.

The basic function of the lagoon is to accept septic and/or holding tanks wastes from sewage haulers; store and treat such wastes until they can be discharged in an environmentally safe manner.

In order to perform this function, the lagoon must meet the following performance standards:

a) The size of the lagoon must be adequate to receive the amount of wastes hauled.

b) The lagoon must be structurally sound to withstand all the forces and pressures that it is likely to encounter especially during winter months.

c) The operation of the facility should be such that it causes no material discomfort to any person; and,

d) Any effluent from the facility should be discharged in such a manner that no environmental degradation is likely to occur.

2.2.1 Lagoon Size

The sizing of the lagoons was based on economic factors since information on required volumes was not available. The capacity of the five lagoons is as follows:

1.	Twelve Mile Bay Lagoon	- 148,960 Imp. Gal.
2.	South Bay Lagoon	- 376,200 Imp. Gal.
3.	Stephenson Lagoon	- 204,360 Imp. Gal.
4.	Dwight Lagoon	- 147,760 Imp. Gal.
5.	Baysville Lagoon	- 201,740 Imp. Gal.
	Total	1,079,020 Imp. Gal.

The liquid depth in each lagoon is limited to 5 feet with an additional 2 foot freeboard, giving a total depth of 7 feet. The berms are 8 feet wide at the top with inside and outside slopes of 3 feet horizontal to 1 foot vertical.

2.2.2 Lagoon Construction

The lagoon cell was excavated in the natural soil and prepared to accept sewage in two ways. The Twelve Mile Bay and the South Bay Lagoon were lined with 2 feet of clay, whereas, the remaining three lagoons made use of a rubber liner (Dupont's Hypalon).

It was reported that the rubber liner was economically feasible in small lagoons (less than 20 acres) because of the ease of installation, thereby reducing labour costs.

Wooden spillways were constructed so that discharging sewage from the hauler's vehicle would not damage the liner.

The lagoon was also fenced off and signed in order to control access to the site. A lockable gate was installed at the entrance and only authorized haulers had keys to the gate.

2.2.3 Capital Cost

The British Columbia Water Resources Services, (May, 1975) reports that "In sparsely populated areas where space is available, sludge lagoons are probably the cheapest method of handling septic tank sludge."

The major variable in the capital cost of this type of operation appears to be the land. The use of crown or municipally owned land greatly reduces the capital expenditure.

The following figures are the total capital expenditures, including land, for the District Municipality of Muskoka's Lagoons:

1.	Twelve Mile Bay Lagoon	- $20,300
2.	South Bay Lagoon	- $32,900
3.	Stephenson Lagoon	- $36,400
4.	Dwight Lagoon	- $15,900
5.	Baysville Lagoon	- $38,800
	Total	$144,300

This works out to a cost of approximately $0.13/Gal. Capacity.

2.2.4 Discharge

Originally, the five lagoons were designed as a total retention lagoon with no discharge, and approval was given on this basis. However, it is quite obvious that the construction of a new cell each time the previous one is full is not practical. Thus, some method of treating and discharging a supernatant will be required. Several methods of treatment may be employed. The lagoon contents may be chemically treated (alum) and then discharged to a receiving stream. On the other hand, retention over a two or three year period may enable the supernatant to be discharged untreated. It may also be possible to use spray irrigation. These methods are all being considered and investigation is continuing. Results of preliminary data on chemical treatment is recorded later in this report.

2.3 Operations

These facilities have been in operation for several seasons now and useful data has been obtained with respect to their operation.

2.3.1 Access Control

Access to the lagoon site is controlled by a lockable gate. The Municipality has supplied authorized haulers with keys to these gates. An authorized hauler is one that lives and works within the municipality and has a license from the Ministry of the Environment.

This type of control appears satisfactory. There does not appear to be a need for the site to be supervised. The only problem encountered to-date, has been the occasional discharge of sewage at the gate. It was reported that this was done by unauthorized haulers from outside the area. It may also be possible that an authorized hauler has forgotten his key and has dumped his load rather than make an extra trip.

These occurences are rare and hopefully will be eliminated once other areas initiate a series of disposal sites.

2.3.2 Odour Control

Under certain conditions, because of the nature of the wastes, the area adjacent to the lagoon will experience offensive odours. Septic tank sludge wastes are organically stronger than domestic sewage; therefore, increasing the likelihood of the lagoon becoming septic.

In order to reduce this possibility, one could consider reducing the liquid depth in the lagoon or employing aerators.

However, the best solution appears to be to locate the facility sufficiently far away from the nearest dwelling. Experience may indicate that a lagoon may be operated on an anerobic basis; thereby increasing the life expectancy for the same surface area.

Only one complaint has been received regarding an odour problem and it is not known whether the complaint was related to the lagoon or to an adjacent landfill site.

It appears that odours will not be a problem if the sites are located in remote areas.

2.3.3 Plastic Bags

One operational problem which was not foreseen, is the appearance of plastic bags in the lagoon.

These bags apparently are used in some toilet equipped motorized vehicles, head equipped boats, cottages during winter season, or by ice fishermen in their ice shelters (fishing huts). It has also been reported that bags of garbage have been deposited in vault privies.

The bags, no matter where they come from, create great difficulty for both the sewage hauler and the municipality. The bags get into the pumping equipment causing blockages. They also tend to float on the surface of the lagoon; thus, hindering the chemical treatment process by interfering with the proper mixing of the chemical and the sewage.

Since the bags are chemically inert, they would have to be physically removed and buried adjacent to the lagoon. There does not appear to be a simple solution to this problem. It may be required that a shredder (comminutor, barminutor, or rotogrator) be installed at each site or the use of plastic bags be controlled at the source to reduce the problem at the lagoons. Further investigation into this problem is required.

2.3.4 Chemical Treatment

As mentioned in Section 2.2.4, some means of discharging the lagoons must be found. In the Spring of 1975, the lagoons were chemically treated with alum. Tables one to five (appendix) record the results of this treatment. The Ministry's criteria for B.O.D. and suspended solids of 15 mg/l for direct discharge was not obtained.

There does not appear to be any correlation between the results. In some cases the B.O.D. reduction was 90% and in another case the B.O.D. was raised by 20%. The same type of variation occured for the suspended solids and the free ammonia.

There could be several reasons for the poor results which should be investigated.

Before the chemical is added to the lagoon, jar tests are performed on a composite sample of the lagoon to determine the best concentration. The chemical can be added to the lagoon in several ways. A high pressure hose sprays the chemical over the surface of the lagoon or the chemical is injected into the lagoon from a barrel located in a boat which slowly traverses the lagoon surface. No matter which method is used, a boat and outboard motor is required to flash mix the chemical with the lagoon contents.

As the boat and motor flash mix the chemical and sewage, the composition of the lagoon contents may differ as a result of stirring; from that obtained in the original composite. This could then result in an improper chemical concentration being applied.

Also, the fact that lagoons were still being used because only one cell was located at each site undoubtedly affected results. This situation is now being altered with the construction of additional cells. This would then enable the contents of the lagoon to settle and possibly enable the natural breakdown to occur under quiescent conditions.

It could also be possible that for this type of waste, another chemical such as ferric chloride or lime may give better results.

Lagoons such as the South Bay lagoon, which have an insufficient spray area adjacent to the site, must be discharged either by transporting the supernatant to a suitable spray area or chemically treating and then discharging. Since the transportation of supernatant to a suitable area may be time consuming and expensive, research into chemical treatment of lagoons is warranted.

2.3.5 Spray Irrigation

Consideration is presently being given to chemically treat the wastes and then employ a ridge and furrow method of disposal for the effluent. This would overcome the high B.O.D. and suspended solids problem. The chemical treatment should enable a higher gallonage/acreage load on the soil. This appears to be a suitable method if sufficient land adjacent to the lagoon is available.

2.3.6 Operating Costs

One distinct advantage of the lagoon system is the low operating costs. The only costs involved are related to the discharging of the facility and road maintenance. Road maintenance costs are a factor that must be considered; but, at this time, such a figure is not available from the District Municipality of Muskoka.

The costs reported by the District Municipality of Muskoka to treat and discharge 200,000 gallons runs about $700 to $1,000 which is between $3.50 to $5.00/1,000 gallons. This cost is substantially higher than that experienced by resort operators, which is about $0.53/1,000 gallons.

There are several possible reasons for this apparent discrepancy.

1. Chemical concentrations required in District lagoons are five times greater than resort lagoons.

2. All treatment equipment is being rented, and

3. Labour costs are higher because of transportation costs and time requirements.

It is reasonable to assume that these costs will diminish as equipment is purchased rather than rented, and the addition of extra cells at each site should reduce the cost/gallon.

CHAPTER THREE

Conclusions and Future Activities

3.1 Conclusions

Preliminary conclusions reached on this type of facility are as follows:

a) A municipally operated facility appears to reduce the number of instances of indiscriminant dumping of sewage by sewage haulers.

b) A network of sewage lagoons is practical in areas where insufficient suitable land is available for the disposal of septic and/or holding tank wastes.

c) The distance of the facility should not be more than 8 to 10 miles from the area that is to be served.

d) Insufficient records are presently being kept to estimate the volume of sewage generated within a geographical area.

e) Rubber liners are economically feasible for smaller installations.

f) Access control to the facility via a lockable gate and keys for authorized haulers appears suitable.

g) Average capital cost within the District Municipality of Muskoka was $130./1000 gallons. The major factor in this cost was land acquisition.

h) Total retention lagoons are not practical.

i) Odour does not appear to be a problem when sites are remotely located.

j) Plastic bags within the facilities create operating problems.

k) Initial chemical treatment results indicate that treatment is not suitable for direct discharge to surface water.

l) Ridge and furrow method of disposal may be an answer to disposal problems providing suitable land is available.

m) Operating cost for the five District lagoons averaged between $3.50 and $5.00/1,000 gallons of sewage.

3.2 Future Activities

1. Research is being considered into the possibility of altering lagoon design. The dissolved oxygen profile may indicate that an anaerobic lagoon rather than aerobic lagoon may be employed in remote areas. Where odours may be a concern, a shallower lagoon, or one equipped with an aerator could be considered.

2. The District Municipality and the Regional Staff will be investigating the plastic bag problem within these facilities.

3. The Ministry is continuing to evaluate and make recommendations regarding chemical treatment on this type of installation. The South Bay lagoon is being considered as a test site.

4. Ministry personnel are continuing to monitor these facilities to ascertain if natural degradation occurs over a period of a year.

APPENDIX

I Advertisement From "Outdoor Stores" Catalogue

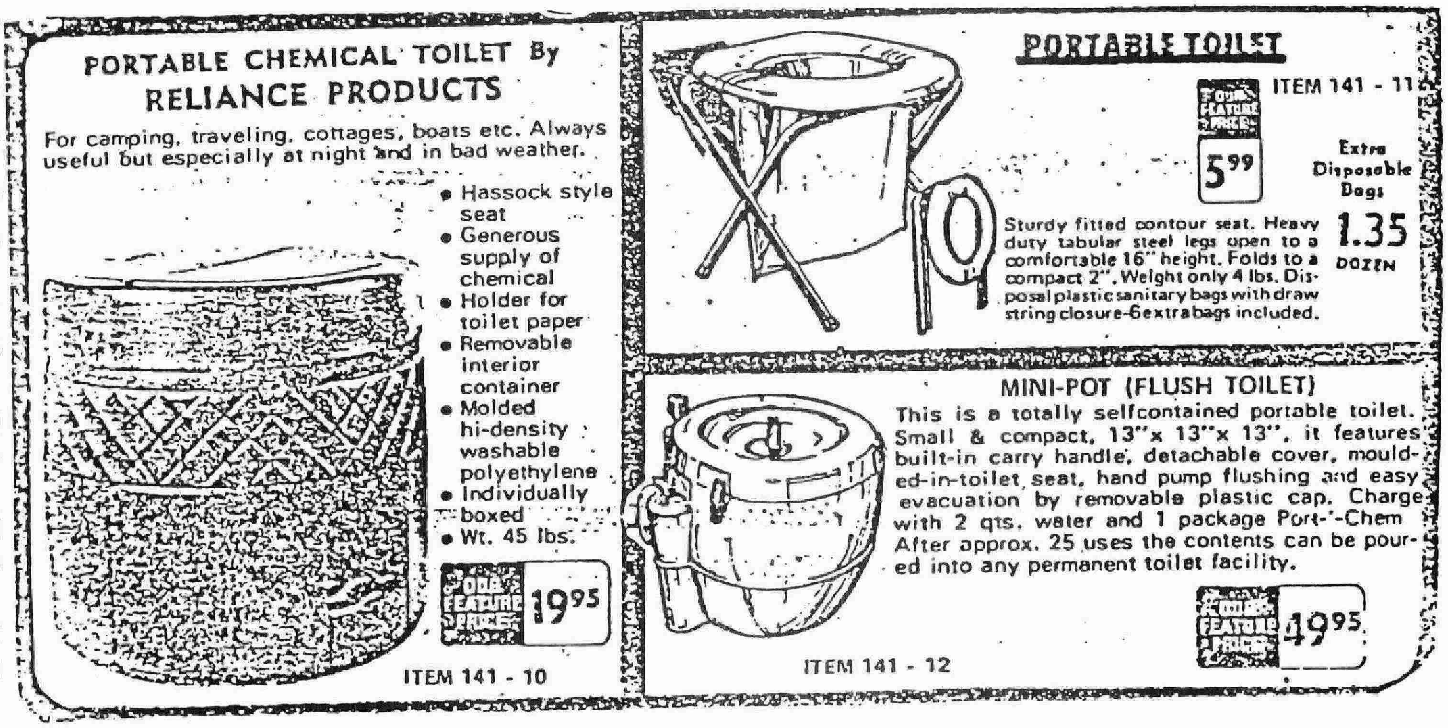

TABLE ONE - Twelve Mile Bay District Lagoon

CHEMICAL TREATMENT RESULTS

	BEFORE TREATMENT				AFTER TREATMENT			
	SURFACE	MID DEPTH	BOTTOM	COMPOSITE	#1	#2	AVGE.	% REDUCTION
B.O.D.	70	320	1300	563	70	50	60	89
SUSPENDED SOLIDS	365	940	7440	2915	300	105	202	93
FREE AMMONIA	5.7	15	20	14	58	58	58	-314
TOTAL KJELDAHL	43	67	320	143	78	72	75	48
NITRITE	L.02	L.02	L.02	L.02	L.02	L.02	L.02	
NITRATE	L.2	L.2	L.2	L.2	L.2	L.2	L.2	
TOTAL PHOSPHORUS	10	16	68	31	2.0	1.0	1.5	95
SOLUBLE PHOSPHORUS	3.6	6.9	9.0	6.5	0.16	0.16	0.16	98
ALKALINITY	124	168	238	177	12	0	6	97
pH	6.9	6.6	6.5	6.7	4.5	4.5	4.5	
TOTAL COLIFORM/100 ml	600×10^3	400×10^3	1400×10^3		0	6×10^3		
FAECAL COLIFORM/100 ml	300×10^3	40×10^3	200×10^3		0	$.18 \times 10^3$		
FAECAL STREP/100 ml	30×10^3	50×10^3	50×10^3		0	$.024 \times 10^3$		

All analyses except pH reported in mg/l unless otherwise indicated.

NOTE: Chemical concentration of 1000mg/l was used.

L means less than.

TABLE TWO - South Bay District Lagoon

CHEMICAL TREATMENT RESULTS

	BEFORE TREATMENT				AFTER TREATMENT			
	SURFACE	MID DEPTH	BOTTOM	COMPOSITE	#1	#2	AVGE.	% REDUCTION
B.O.D.	95	200	260	170	150	150	150	12
SUSPENDED SOLIDS	70	155	270	125	140	130	135	-8
FREE AMMONIA	100	185	250	150	180	190	185	-23
TOTAL KJELDAHL	140	240	300	190	190	190	190	0
NITRITE	0.02	0.04	0.02	0.02	L.02	L.02	L.02	
NITRATE	L.2	L.2	L.2	L.2	L.2	L.2	L.2	
TOTAL PHOSPHORUS	21	36	46	28	0.16	0.08	0.12	99
SOLUBLE PHOSPHORUS	16	24	35	21	L.02	.02	L .02	100
ALKALINITY	594	962	1256	776	40	40	40	95
pH	7.5	7.2	7.0	7.3	4.6	4.6	4.6	
TOTAL COLIFORM/100 ml	400×10^3	200×10^3	600×10^3	400×10^3	0	0		
FAECAL COLIFORM/100 ml	60×10^3	120×10^3	200×10^3	130×10^3	0	0		
FAECAL STREP/100 ml	50×10^3	30×10^3	40×10^3	50×10^3	0	0		

All analyses except pH reported in mg/l unless otherwise indicated.

NOTE: Chemical concentration of 1000mg/l was used.

L means less than.

TABLE THREE - Stephenson District Lagoon

CHEMICAL TREATMENT RESULTS

	BEFORE TREATMENT				AFTER TREATMENT			
	#1	#2	#3	AVGE.	#1	#2	AVGE.	% REDUCTION
B.O.D.	2100	3500	1900	2500	250	250	250	90
SUSPENDED SOLIDS	4175	17000	4490	8555	35	30	33	100
FREE AMMONIA	88	100	76	88	110	110	110	-25
TOTAL KJELDAHL	180	380	200	253	120	120	120	53
NITRITE	0.06	0.04	0.04	0.05	L.02	L.02	L.02	60
NITRATE	L.2	L.2	L.2	L.2	L.2	L.2	L.2	
TOTAL PHOSPHORUS	50	120	60	77	0.28	0.24	0.26	100
SOLUBLE PHOSPHORUS	26	32	23	27	0 .02	0.04	0.03	100
ALKALINITY	420	634	498	517	32	32	32	94
pH	6.6	6.6	6.7	6.6	4.8	4.7	4.8	
TOTAL COLIFORM/100 ml	Not Available				0	0		
FAECAL COLIFORM/100 ml	Not Available				0	0		
FAECAL STREP/100 ml	Not Available				Not Available			

All analyses except pH reported in mg/l unless otherwise indicated.

NOTE: Chemical concentration of 1000mg/l was used.

L means less than.

TABLE FOUR - Dwight District Lagoon

CHEMICAL TREATMENT RESULTS

	BEFORE TREATMENT				AFTER TREATMENT			
	SURFACE	MID DEPTH	BOTTOM	COMPOSITE	#1	#2	AVGE.	% REDUCTION
B.O.D.	36	95	140	90	120	95	108	-20
SUSPENDED SOLIDS	285	225	520	343	570	265	418	-22
FREE AMMONIA	12	31	42	28	44	44	44	-57
TOTAL KJELDAHL	36	48	71	52	65	130	98	-88
NITRITE	L.02	L.02	L.02	L.02	L.02	L.02	L.02	
NITRATE	L.2	L.2	L.2	L.2	L.2	L.2	L.2	
TOTAL PHOSPHORUS	9.6	13	17	13	6.8	0.60	3.7	72
SOLUBLE PHOSPHORUS	2.5	6.9	13	7.5	0.02	0.02	0.02	100
ALKALINITY	90	206	258	185	24	25	25	86
pH	6.7	6.4	6.3	6.5	4.6	4.6	4.6	
TOTAL COLIFORM/100 ml	250×10^3	30×10^3			130×10^3	8×10^3		
FAECAL COLIFORM/100 ml	13×10^3	1×10^3			0	0		
FAECAL STREP/100 ml	10×10^3	0			200	0		

All analyses except pH reported in mg/l unless otherwise indicated.

NOTE: Chemical concentration of 1000mg/l was used.

L means less than.

TABLE FIVE - Baysville District Lagoon

CHEMICAL TREATMENT RESULTS

	BEFORE TREATMENT				AFTER TREATMENT			
	SURFACE	MID DEPTH	BOTTOM	COMPOSITE	#1	#2	AVGE.	% REDUCTION
B.O.D.					44	17	31	
SUSPENDED SOLIDS					100	55	78	
FREE AMMONIA		NOT AVAILABLE			0.1	L.1	.1	
TOTAL KJELDAHL					7.6	2.8	1.4	
NITRITE					L.02	L.02	L.02	
NITRATE					L.2	L.2	L.2	
TOTAL PHOSPHORUS					6.8	1.1	4.0	
SOLUBLE PHOSPHORUS					1.3	L.02	0.66	
ALKALINITY					72	56	64	
pH					6.7	6.9	6.8	
TOTAL COLIFORM/100 ml	48	50			- - - -	Not	Available	- - - -
FAECAL COLIFORM/100 ml	12	8			- - - -	Not	Available	- - - -
FAECAL STREP/100 ml					- - - -	Not	Available	- - - -

All analyses except pH reported in mg/l unless otherwise indicated.

NOTE: Chemical concentration of 1000mg/l was used.

L means less than.

CAPITAL COST BREAKDOWN

	Twelve Mile Bay	South Bay	Stephenson	Dwight	Baysville
Engineering	2,800	2,300	1,700	1,400	1,700
Land	8,700	5,400	16,700	-	25,700
Labour	2,200	6,000	6,000	4,300	3,300
Equipment	6,100	17,200	4,900	3,400	2,300
Misc. Material	500	2,000	1,800	1,440	700
Liner	-	-	5,300	5,360	5,100
Total	20,300	32,900	36,400	15,900	38,800

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